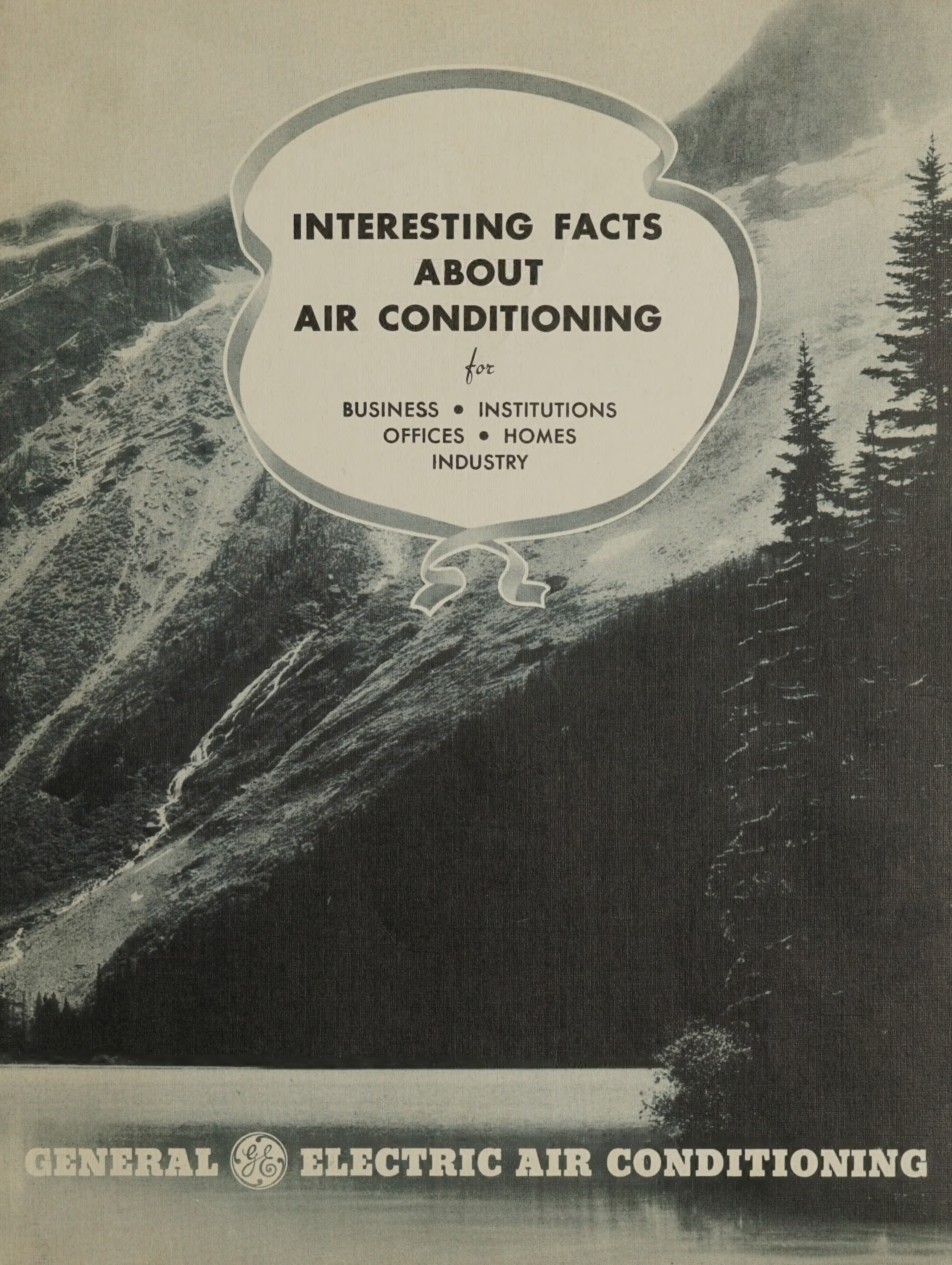
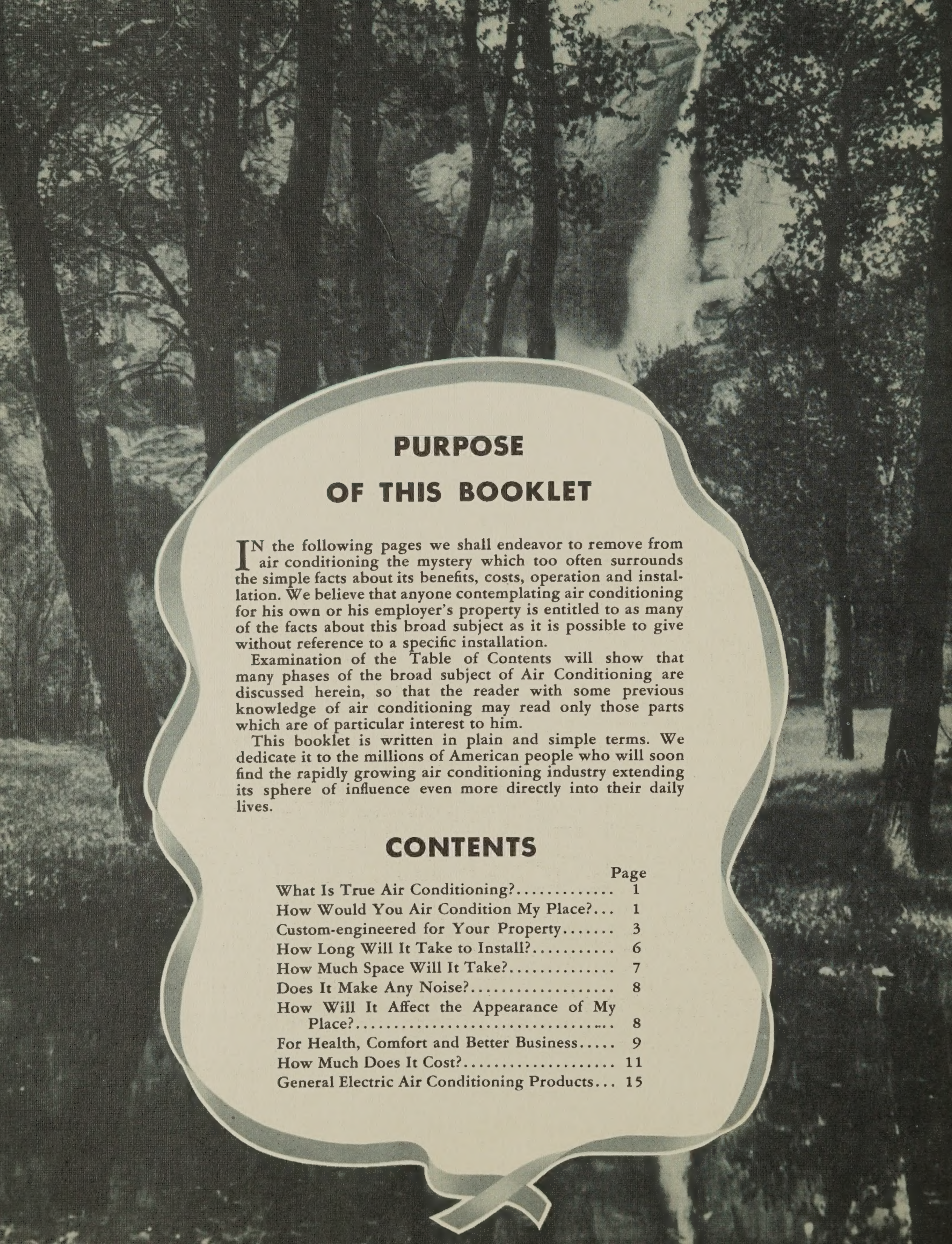
INTERESTING FACTS ABOUT AIR CONDITIONING

for

BUSINESS • INSTITUTIONS
OFFICES • HOMES
INDUSTRY



GENERAL ELECTRIC AIR CONDITIONING



PURPOSE OF THIS BOOKLET

IN the following pages we shall endeavor to remove from air conditioning the mystery which too often surrounds the simple facts about its benefits, costs, operation and installation. We believe that anyone contemplating air conditioning for his own or his employer's property is entitled to as many of the facts about this broad subject as it is possible to give without reference to a specific installation.

Examination of the Table of Contents will show that many phases of the broad subject of Air Conditioning are discussed herein, so that the reader with some previous knowledge of air conditioning may read only those parts which are of particular interest to him.

This booklet is written in plain and simple terms. We dedicate it to the millions of American people who will soon find the rapidly growing air conditioning industry extending its sphere of influence even more directly into their daily lives.

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A General Electric Air Conditioning System is a Co-ordinated System

WHAT IS TRUE AIR CONDITIONING?

In a day when the term "Air Conditioning" is being bandied about altogether too carelessly, it is well to define our subject. General Electric, from its entrance into the industry, has adhered to the following definition:

"TRUE Air Conditioning is the combination of functions as here listed, to the proper degree, under automatic control, and without disturbing noise, to give the most healthful and comfortable indoor atmosphere in Winter, in Summer or throughout the entire year."

YEAR 'ROUND AIR CONDITIONING	HEATING HUMIDIFYING	WINTER AIR CONDITIONING
	CLEANING CIRCULATING VENTILATING	
	COOLING DEHUMIDIFYING	SUMMER AIR CONDITIONING

There are on the market today, fans, humidifiers, electric heaters, and other appliances which may perform one or more of the functions of air conditioning, yet which do not perform the minimum necessary to properly merit the name of "air conditioner." Many of these appliances efficiently and usefully perform the limited functions for which they are intended, but when they are called "air conditioners," more is promised than can be fulfilled. Only with *true* air conditioning can full benefit be obtained.

HOW WOULD YOU AIR CONDITION MY PLACE?

The answer to this question is seldom finally known until the structural and mechanical details of your place have been completely surveyed, engineering calculations accurately made to determine capacity requirements, and equipment carefully selected to most economically meet the calculated requirements as well as the structural and other practical limitations of your place. Then and only then can we tell you exactly how we would air condition your place.

Though this sounds like a complex procedure, it is a relatively simple and straightforward process in the hands of an experienced G-E trained engineer. Of course, if you want only a general idea of how to air condition your place, and about how much it would cost, this same engineer can give you an approximation in a very short time.

The kind of system finally selected for your place will depend largely upon its structure and the nature of its occupancy.

The Central Plant System

Unless it is a small single room, or the structure of the building prevents the use of ducts, it is most likely that the method selected will be known as the "central plant system" in which the air is conditioned in a remote air conditioner and properly distributed to desired locations by means of ducts.

Figures 1 and 2 show schematically a system of this kind for summer service. In the air conditioner are finned tubes kept cold (from 40 to 50 degrees, depending on the nature of the cooling load) by refrigerant from the condensing unit (the refrigerating machine consisting of motor, compressor and condenser). When it reaches these coils the mixture of recirculated air and outdoor air for ventilation has passed through the filters and is cleaned of dust and dirt. As it passes through the cooling coils it is cooled from a temperature of 80 to 90 degrees, depending on the indoor temperature and amount of outdoor air, to a temperature usually in the range from 60 to 75 degrees, depending on the calculated nature of the load. As it is cooled, part of the air comes in immediate contact with the cold surfaces and is temporarily cooled so low that moisture is

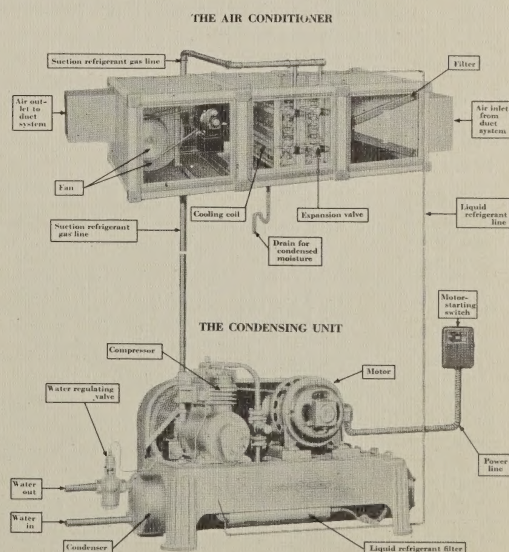

Fig. 1. Elements of small central plant air conditioning system.

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condensed from the air on the coils (as on a glass of ice water on a humid day) and drips into a drain to be carried away. It is in this manner that the humidity is lowered by a summer air conditioning system.

The air then passes through the motor-driven centrifugal fan which acts to draw the air through the filters and coils and to force it through the ducts. On larger air conditioners the fan and motor are usually mounted externally and connected to the ducts and conditioner during installation.

The condensing unit is the heart of the summer air conditioning system. The cooling coils in an air conditioning system correspond to the evaporator or freezer in an electric refrigerator. The cooling coils are kept cold by the evaporation of liquid refrigerant forced into them through an automatic valve by the pressure built up by the compressor. The compressor withdraws the cold evaporated refrigerant from the coils, compresses it to a hot gas at high pressure and discharges it into the condenser. Water from the city mains, a well or a cooling tower flows through tubes in this condenser and cools the refrigerant, reliquefying it, and extracting the heat which it took out of the air in the cooling coils. Thus the refrigerant is again a liquid, ready to start another trip to the cooling coils to absorb more heat.

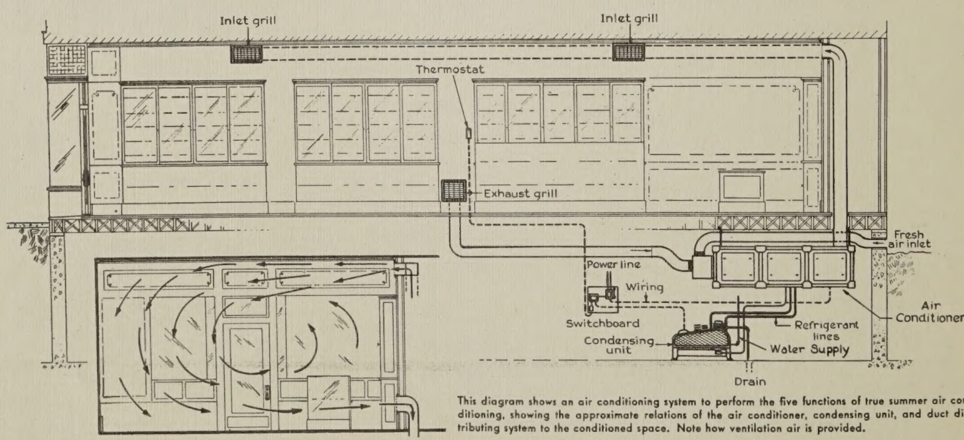
This is the essence of the operation of a simple central plant system and an actual installation of this kind is shown in Fig. 3.

This same kind of system can be used to perform winter service by the inclusion in the air conditioner of finned heating coils, supplied with steam or hot water from a General Electric Furnace or from the central heating plant of a large building. By the use of a humidifier in the same conditioner the dry air in winter can be humidified.

The central plant system is designed specifically for each individual application, and it has many variations. Besides the type of system illustrated, it may be used to condition an entire building with ducts leading to all rooms or spaces, with suitable automatic controls for regulating temperature and air delivery in each space or in logically selected major zones of the building having different exposures to the sun and prevailing winds.

In some cases the structure of a large building makes it necessary to use a number of central plant air conditioners, located and concealed at strategic points in the building. Each conditioner has its own duct system, but the coils of all of them are supplied with refrigerated water from the basement. This water is cooled in a tank in which are immersed the cooling coils supplied with refrigerant from the condensing unit.

In very large systems it is often desirable to employ several condensing units instead of one large one, because during periods when the cooling load is light one or more of the condensing units can be automatically stopped if not needed. This enables the plant to run at maximum efficiency even at light loads, and saves money in operating cost. It means less wear of the machines and provides longer life and lower maintenance cost. Fig. 4 shows an installation of multiple condensing units.



This diagram shows an air conditioning system to perform the five functions of true summer air conditioning, showing the approximate relations of the air conditioner, condensing unit, and duct distributing system to the conditioned space. Note how ventilation air is provided.

Fig. 2. Schematic diagram of typical central plant system for small store.

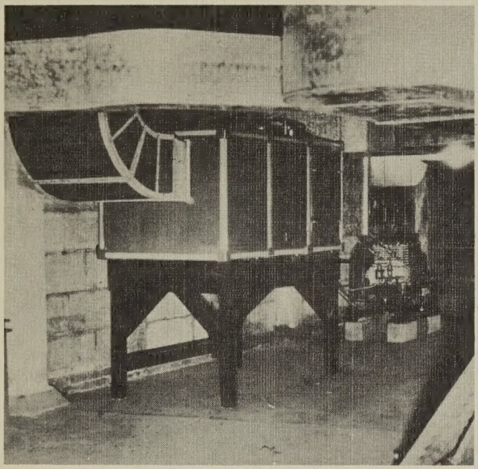


Fig. 3. General Electric central plant system (5 hp) in Royal Fur and Garment Co., Charleston, W. Va.

Unit Air Conditioners

If we go to the other extreme and consider the single small room, such as an executive office or a room in the home, it is usually less costly to use a unit air conditioner, located within the room to be conditioned. Such a conditioner operates on exactly the same principle as a central plant system; the condensing unit may be located in the basement, in an adjacent room, or it may be especially sound proofed and enclosed within the decorative cabinet of the air conditioning unit. Typical units are shown in Figs. 5 and 6.

Unit air conditioners are available for summer service only, or for year 'round service. In the latter case they are usually connected to steam pipes in place of a radiator, as in Fig. 13. Either type of unit may have a window duct connection for bringing in ventilation air.

One variety of the unit air conditioner has a built-in air-cooled condensing unit requiring no water or drain connections. Air from outdoors is brought in through a window duct by a separate fan to cool the refrigerant in the condenser. After performing this function it absorbs the moisture condensed by the cooling coils and is discharged out the window. Such a unit is shown in Fig. 7.

Unit Systems

In some large buildings with many rooms, such as an office building, the construction of the building is such that it is almost impossible to use ducts. In such cases buildings have been air conditioned by employing one or two unit air conditioners in each room, all served by a system of piping carrying refrigerated water in summer and heated water in winter. The refrigerating plant in this case is usually located in the basement and does not differ in operation from the water cooling plant of a large system of the indirect central plant type.

Which System to Use?

Thus your place would be air conditioned by one of the above three methods or even a combination of them. The final selection would be made only after careful engineering analysis of the building structure and the calculated requirements to determine which method or combination will give the best results at the lowest cost in the long run. One may say, though, that where adaptable, the central plant system is the most flexible, can be designed to fit most precisely the load requirements, and often costs somewhat less per unit of capacity required.

CUSTOM-ENGINEERED FOR YOUR PROPERTY

Now and then we hear someone say "Oh, I wouldn't buy air conditioning now; it isn't perfected yet. A friend of mine bought a system and it wasn't at all satisfactory." Yet an investigation of these occasional unsatisfactory systems would inevitably show that their faults were not due to the equipment itself nor to the standards of air conditioning procedure set up by responsible manufacturers and consulting engineers, but that they *were* due to an inexperienced man's failure to follow established practices of air conditioning engineering or to cheap or inexperienced installation work.

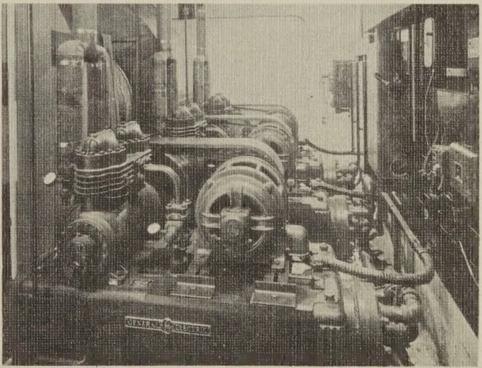


Fig. 4. Three G-E condensing units supplying one air conditioner in Capitol Theater, Miami, Fla., for flexible operation with varying cooling loads.

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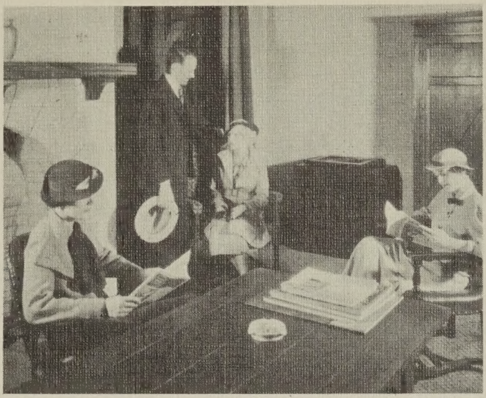

Fig. 5. Room cooler for summer service only installed in reception room.

It can well be pointed out here that all the elements which go to make up a high quality air conditioning system are neither new nor unperfected. Refrigerating compressors, motors, valves, electrical switches, thermostats, filters, and cooling and heating coils have all been manufactured and in use for many years and their characteristics and properties are well understood by experienced engineers. The other elements of a system—the piping, tubing, wiring, sheet metal ducts, air distributing grilles—are even older in practice than the machinery itself. So, in the mechanical apparatus for air conditioning there is nothing new or unknown.

Therefore, the success of an installation depends upon the knowledge and ability of the engineer who calculates the requirements of your job, and who selects the proper combination of mechanical elements by means of drawings and written specifications. The success of the installation also depends upon the experience and ability of the engineer who supervises the group of contractors and workmen that create the system from the mechanical equipment, in accordance with the drawings and specifications.

While General Electric has dedicated its research and manufacturing resources to the production of equipment having the highest qualities of economy and long life, it has devoted an even greater effort to seeing that the engineering departments of its distributors are made up of men who can correctly design and install successful air conditioning systems. And in this respect the engineers of G-E Distributors and Dealers have made a record of outstanding achievement.

How an Engineer Designs an Air Conditioning System

Without becoming involved in technicalities, it is desirable to explain the engineering procedure that is the foundation of a successful air conditioning system. It is an interesting story and it can be of help to the buyer who wants to insure the success of his purchase by making certain that it is founded upon sound engineering.

In considering this part of the story of air conditioning let us keep in mind that the primary function of an air conditioning system is to maintain specified conditions of temperature and humidity *uniformly* throughout the spaces served. Therefore, except for the single room of ordinary size, we must accept the unavoidable requirements that conditioned air be diffused into the air conditioned spaces *at a number of points*. This means that we must employ either several unit air conditioners or a system of metal ducts to carry the air to the proper points. Even if ducts are eliminated by the use of units, each unit must be served by wiring, drain, and piping concealed from view in the best manner possible.

Hence, without exception, the design of our air conditioning system from the very beginning requires a thorough consideration and knowledge of the structure of the building. Indeed, the final mechanical arrangement of the system is usually dependent on the building structure, and because two buildings are rarely alike, it is easy to see why each good air conditioning system must be custom-engineered.

So the first step is an engineering survey of the premises (or of the architect's plans and specifications for a new building). Basically this survey provides the dimensions and details of the structure, and data on occupancy and heat-producing appliances, so that the capacity requirements may be precisely calculated by the accurate G-E methods of

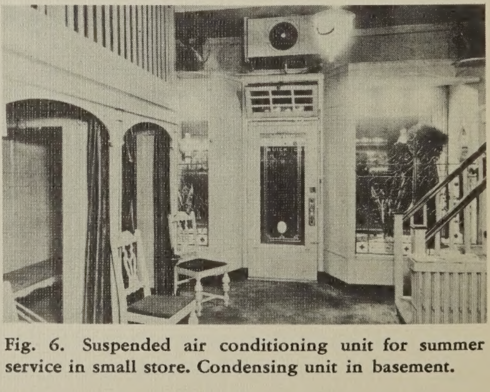

Fig. 6. Suspended air conditioning unit for summer service in small store. Condensing unit in basement.

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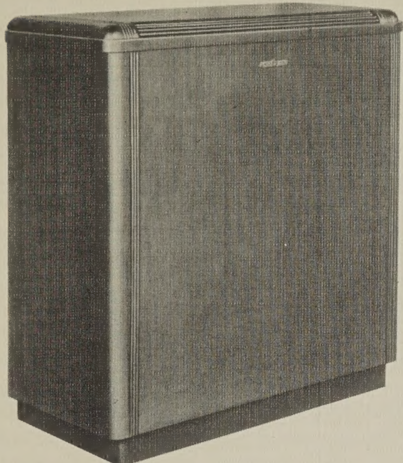

Fig. 7. Self-contained room unit for complete summer air conditioning. Air-cooled condenser. Requires only electric power; no water or drain necessary.

determining cooling and heating loads. But this is only a routine function of the survey. When performed by a G-E trained engineer, there is a tireless search for facts to enable him to better serve and protect the interests of the buyer.

He is continually on the lookout for ways to save money for his prospective client. He analyzes the possibilities of reducing the cooling and heating loads by various inexpensive means to lower the first cost of the installation. He may spend a substantial length of time in the premises analyzing and visualizing various locations for equipment and the mechanical arrangements of the system, to determine the least costly and most effective layout from the standpoint of performance, appearance, use of space and minimum alteration of the building structure. He checks the power, water and drain facilities to make sure they are adequate, and if not, to find a way to make them adequate at minimum expense to the buyer.

These and many other important details are part of the survey of a G-E trained engineer. Nor is he usually content with a single visit; he may return to the premises several times to check the suitability of certain items as his design progresses.

Having the basic data on the structure (from his survey of the premises or the building plans), the engineer proceeds to calculate the cooling load (and heating load, too, if winter operation is included).

Determining the Cooling Load

In determining the cooling load every source of heat within the spaces must be accounted for, lest the system be incapable of maintaining proper conditions when installed. The five main sources of heat which must be calculated are as follows:

1. Heat which will flow through walls and windows from the hot outdoors (or from adjacent uncooled rooms) to the cooled interior.

2. Heat from the people who will occupy the air conditioned space.

3. Heat from the outdoor air which is brought in and cleaned and cooled for ventilation. (Obviously the more ventilation air from out-of-doors to be cooled the greater the required capacity of the system. The amount of ventilation air is at the discretion of the engineer. Skimping on this may mean lower first cost, but there is a minimum amount which must be used for each type of installation to prevent odors.)

4. Heat from electric lights and other heat-producing appliances such as toasters, ranges, coffee urns, motors, hot water pipes, etc.

5. Heat from the direct rays of the sun which beat upon the roof and walls and which shine almost unrestrictedly through window glass. (The magnitude of the sun load is different at every hour of the day. It was common practice to *estimate* the sun load, until General Electric, a few years ago, worked out the first accurate method of calculation which could be checked by laboratory tests for all conditions.)

The heat from people, ventilation air and some kinds of appliances is composed in part of moisture or water vapor which must be condensed on the cooling coils in the air conditioner. Thus the total cooling load is made up of "latent heat" which must be removed to reduce the humidity, as well as "sensible heat" which must be removed to reduce the air temperature.

For an area with several different exposures it is necessary to make calculations for two or more logical zones, for in the final design each of these zones will probably be provided with individual control to maintain comfortable conditions regardless of varying wind and sun effects.

The determination of cooling load involves not only the numerical calculation of the elements of the cooling load, but their adjustment to the time of day when their effective total is greatest. The G-E trained engineer does not stop even here, however, but proceeds to analyze each component part to see whether by the use of awnings, insulation, attic ventilation, or other means, he can reduce the cooling load in order to save money on both first cost and operating cost.

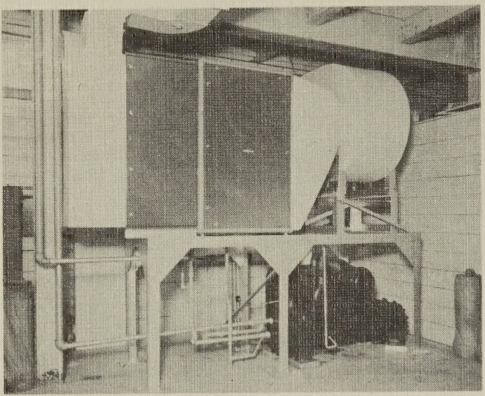

Fig. 8. G-E 15 hp system compactly arranged to conserve floor space, serving offices of Goodyear Tire and Rubber Co., Dallas, Texas.

Selecting the System

Having finally determined the correct cooling load, the engineer is ready to plan the duct layout and select the equipment. These two steps are usually worked out together, because the problems of the best arrangement of ducts, the location of equipment, the total amount of air flow, the actual equipment combinations, and the control methods are all interdependent.

The engineer must select the total air delivery to give adequate air movement in the occupied areas; for summer air conditioning it is best not to have less than eight complete circulations per hour and not more than fifteen, except in special cases. The amount of air flow affects both the size and cost of ducts, cooling coils, blower and motor; and it must be such that the delivered air is not cold enough to cause drafts. Therefore, within a certain range the engineer is free to select an air flow that makes possible a minimum first cost, all of the above factors being considered.

The duct layout involves the simultaneous problems of minimum length of run, most inconspicuous and attractive locations, ease of concealment, limiting air velocities for quiet operation, insulation requirements, and minimum structural alterations of existing buildings. These must all be studied to insure successful operation at lowest cost.

The location of equipment affects the amount of duct work, the costs of furnishing power and water and running refrigerant piping, and the elimination of noise and vibration.

The equipment combination must be picked to have adequate total capacity, to give the selected air delivery, and to have the proper capacity for moisture removal to maintain specified values of relative humidity. This last requirement is very important for producing comfortable and healthful conditions.

The selection of controls must provide for safe operation, for automatic regulation of temperature and the operation of equipment in response to load variations, for special control of humidity in some cases, and for zoned operation where necessary. The minimum control equipment permitted would be the requisite safety controls, with manual regulation of temperature. The extent to which automatic controls will be selected depends on the convenience desired and the economy of operation which additional controls will produce. The inclusion of zone controls, special humidity controls, automatic ventilation air regulators, and differential thermostats for regulating indoor temperatures in relation to outdoor temperatures, may be worth the additional cost in many cases.

HOW LONG WILL IT TAKE TO INSTALL?

All too often air conditioning companies have lost orders solely because their answers to this question called for a longer time than that of someone else. And sometimes the successful bidder discovered too late that he was over-optimistic.

The simple self-contained room unit may be installed in a few hours, but the central plant system for a small store may take several weeks. The huge installation for a complete building may take many months.

There is, of course, a strong temptation for one who has purchased an air conditioning system to clamor for immediate installation, especially when hot weather is at hand. But the central plant system is not an accessory or appendage to the premises; a

Fig. 9. The air conditioner and condensing unit for this Darling Shop in Harrisburg, Pa. are located in a storeroom behind the partition at the rear of the store.

properly installed system becomes a permanent part of the building, designed to last for many years, and should be installed with the care and thoroughness with which the building itself was constructed. Rushing an installation to gain an extra week's operation is not good economy if that haste will in any way lessen the dependability of the system during the many years to come.

The cost of installation labor and materials for a central plant system may often represent more than fifty cents of each dollar spent by the owner; this part of the job is not standardized to nearly the extent that the equipment is, and therefore represents the greatest variable in cost among the bidders. The amount and quality of installation work proposed by each air conditioning company should be most carefully analyzed if a fair cost comparison is to be made and if the buyer wishes to protect himself against extra costs not included in the contract.

All or any of the following items of installation work and corresponding materials may be part of an air conditioning contract: duct work; electric power wiring to motors; electric control wiring; new electric power service; water piping for condenser water; piping to cooling tower; drain piping; steam piping; refrigerant piping; insulation of ducts; insulation of steam or refrigerant piping; soundproofing of ducts; soundproofing of machinery room; painting of ducts; painting of walls, ceilings, etc.; building insulation; foundations for equipment; reinforcing of floors or walls to carry equipment loads; cutting floors, walls, etc. for duct and pipe passages; constructing machinery room; concealment of ducts or pipes with plaster furring; removing discarded equipment.

These are the more common items; in special cases there may be many others. Moreover, in doing all this work the conscientious bidder takes into account overtime labor to avoid disrupting the normal activities of the establishment to any required extent. So perhaps the bidder who offers to do the job in the shortest time has overlooked one or more of these many items in his estimate. And to contract for something not anticipated isn't conducive to the most successful installation.

HOW MUCH SPACE WILL IT TAKE?

This is a vital point in the preliminary consideration of the purchase of air conditioning, especially in the establishment where space is already at a premium.

G-E trained engineers are taught to give full consideration to this problem at all times, and in count-

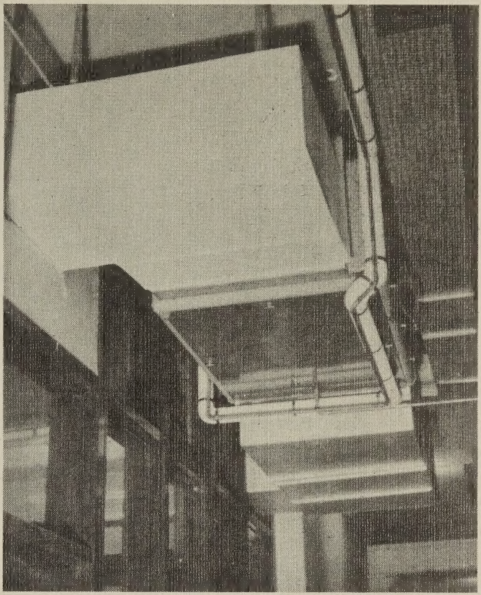

Fig. 10. Air conditioner suspended in corridor serving adjacent tenant space in Pierce Building, St. Louis, Mo. It will later be hidden by false ceiling.

less cases they are able to find equipment locations which do not make it necessary to give up any space previously in use.

Where adequate basement space is available, it is desirable to locate all of the equipment there, especially the heavy condensing unit which should be mounted on a solid foundation. Frequently it is possible to mount the air conditioner above the condensing unit to conserve space, as is shown in Fig. 8.

In a great many cases only the condensing unit is located in the basement and the air conditioner suspended from the ceiling of one of the floors above, near the air conditioned space. Such locations might be in file rooms, stock rooms, washrooms, corridors, or even in the air conditioned space itself, concealed by a wall-board or plastered enclosure. Installations like these are shown in Figs. 9 and 10.

Where the building structure is sufficiently strong, or can be inexpensively reinforced, all of the equipment may be located on the air conditioned floor in a sound-proof machinery room. Quite frequently the air conditioner is located on the roof in a weatherproof enclosure, as in Fig. 11. If the roof is strong enough, the condensing unit may be located there.

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Fig. 11. Penthouse enclosing G-E air conditioning system for one zone of McCorry store in Miami, Fla. Note the ducts lashed to one roof to withstand high winds.

The locations of equipment can be as varied as the structure and layout of different buildings. Rarely do the space requirements of air conditioning equipment present a really difficult problem.

DOES IT MAKE ANY NOISE?

While it is possible to measure noise levels scientifically and compare the intensities of various sounds with a noise meter, the reaction of various individuals to the same noise may be quite different, depending on the state of nervous or mental fatigue, sensitivity of hearing, personal temperament, and other factors.

Many people have become accustomed to the fanfare of street noises admitted through opened windows, the whir of an electric fan in summer, and the hissing of radiators and hammering of pipes in winter.

Any or all of these objectionable sounds can be greatly reduced or eliminated through the installation of a good air conditioning system which can supply better ventilation than opened windows, making it possible to keep windows closed. Many air conditioning systems, particularly in new or remodeled premises, eliminate the need for radiators. If a previously noisy radiator system is to work in conjunction with an air conditioning system, it can usually be quieted at nominal cost through modernization.

A properly designed air conditioning system itself makes very little noise in the occupied spaces. In extreme cases, such as broadcasting studios, the noise level can be reduced so that it cannot be picked up even by sensitive microphones.

The sources of sound in an air conditioning system are the moving mechanical parts, such as the motors, fan, and compressor, and the air motion in the fan, and through the coils, ducts, and supply and return grilles.

Mechanical sound of the moving parts is kept to a minimum in the occupied spaces by the use of equipment inherently designed and manufactured for quiet operation, by flexible duct connections to the air conditioner and fan, and by selecting suitable locations and foundations for the equipment.

Air sounds are kept to a minimum by the use of proper fan speeds and proper air velocities through the coils, ducts and grilles, and occasionally by the use of acoustic insulation in the ducts.

Thus we see that quietness of operation is partly achieved by the equipment manufacturer, and partly by the skill of the engineer who designs the system for the owner's premises.

In the design of its products General Electric is striving continually to produce quieter operating equipment. Every new design is carefully tested in sound-proof rooms, Fig. 12, so quiet that the human ear can detect not the slightest sound from outside. An original design is often modified and retested many times because the sensitive noise meter says it is not sufficiently quiet in operation. Moreover, there is additional assurance of quiet operation through testing of units in regular production before they are shipped.

It is therefore possible to install a General Electric Air Conditioning System so that the sound-level in the occupied spaces is substantially lower than it was before the installation.

HOW WILL IT AFFECT THE APPEARANCE OF MY PLACE?

There are two answers to this question—one for unit air conditioners in the occupied spaces, and the other for the central plant system using duct distribution.

With unit air conditioners housed in attractive cabinets, such an installation is about equivalent to adding another element of furniture to the room. Modern trends in cabinet design enable the unit to harmonize with the furniture and furnishings of most rooms. For a small additional cost the cabinet can be painted or decorated to match or harmonize with various color schemes. Fig. 13 shows a standard unit that fits harmoniously into its surroundings. Certainly it is less objectionable in appearance than an ordinary exposed radiator.

In the case of the central plant system it is often possible to conceal all evidence of the air conditioning system, save for the air supply and return grilles. Since the air conditioner and condensing unit are usually

located in the basement, in storage or work space, on the roof, in an isolated machinery room, or in a combination of these, the equipment itself does not enter into the matter of appearance of the occupied space.

The duct work which carries the air to the proper distributing points is often concealed behind partitions so that only the grilles are evident, as in Fig. 14, or if it is necessary to run ducts in the occupied space, they may be concealed by lath and plaster furring. In retail stores ducts are frequently run above wall cases and concealed by a plaster or wall board case in front of the duct, as illustrated in Fig. 9. If the buyer prefers not to pay the cost of concealing ducts in occupied spaces it is usually possible to arrange them without serious detriment to the appearance of the interior.

G-E trained engineers are taught to search for ways to achieve symmetry, inconspicuousness and attractiveness in designing General Electric Air Conditioning Systems.

FOR HEALTH, COMFORT AND BETTER BUSINESS

The history of air conditioning during its first decade of widespread commercial and industrial usefulness is a story of the unfolding of benefit to humanity as vital and romantic as the histories of electrification, automobiles, communication, or railroad transportation.

Of course, the development of air conditioning has been accompanied by the inevitable ballyhoo of the super-enthusiasts and spell-binders who heralded it as everything from the panacea for all economic ills to the creator of a super-race of people. Yet the plain facts about the benefits of air conditioning are even more interesting than the wild prattlings of the ballyhoo artists.

What are some of these facts?

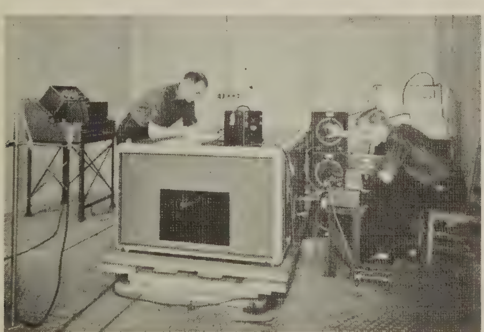


Fig. 12. G-E central plant air conditioner being tested for performance in sound room in Air Conditioning Laboratory at Bloomfield, N. J. plant.

Fig. 13. Year 'round air conditioning unit in private office, National Savings Bank, Albany, N. Y.

Air Conditioning Benefits Health

It is known that air conditioning is beneficial to human health in many ways. It has been demonstrated that relief from excessive heat through summer air conditioning reduces fatigue and improves general body health. It is believed that cleaning and humidification of the air in winter helps the body ward off respiratory illness, although this has not yet been definitely established by members of the medical profession. However, reports from large general offices with year 'round air conditioning show reductions of over 40 per cent in lost-time due to colds and related ailments. This is further substantiated by reports from owners of G-E winter air conditioning systems in homes that the number of colds contracted by members of the family has been substantially reduced.

Research and practical trial indicate that nearly all people having hay fever caused by pollen can be relieved by occupying an air conditioned room. Some cases of asthma, particularly pollen asthma, have been relieved by air conditioning. The ever-widening use of air conditioning in hospital operating rooms and patients' rooms is demonstrating much easier post-operative convalescence, material benefits in cardiac cases and substantial aid to the surgeon in allowing him to work in comfort instead of enervating heat.

Air Conditioning Produces a New Kind of Comfort

Comfort, both winter and summer, was air conditioning's original point of appeal, even though the early systems often did little more than severely chill the occupants because of incorrect temperature settings. Personal comfort is still one of the major benefits of air conditioning, and with modern knowledge of proper control, regulation of indoor temperatures with outdoor conditions, adequate dehumidifi-

Fig. 14. Interior of Bond Clothing Store in Cleveland, Ohio. Discharge grilles in wall are the only visual evidence of the G-E air conditioning system.

cation, and uniform air distribution, the air conditioning systems of today produce delightfully comfortable conditions.

Without air conditioning the air at the floor of a heated room in winter is usually cold, stagnant and lacks an invigorating quality, and is so low in humidity that the drying effects on the skin and respiratory passages actually make us uncomfortable. In place of these discomforts, air conditioning, through humidification, cleaning and gentle circulation, actually makes us feel far more comfortable in winter. With an air conditioning system under automatic control and supplying adequate ventilation, windows can be kept closed to shut out noise, and the occupant is free from the annoyance of manipulating windows and valves to keep from being too cold or too hot. These benefits are in reality a contribution to bodily and mental comfort.

In summer, the comfort produced by good air conditioning is as beneficial as winter comfort. When we are comfortable, we do more and better work, sleep better, enjoy our meals and entertainment far more, and generally conserve energy to the end that we really enjoy a better world in which to live and work.

Business Air Conditioning Helps Profits

In the business world, air conditioning has definitely achieved the status of an investment in increased business, improved employee performance, and better service to patrons. The progressive business man considers the expense of air conditioning an investment as worthy of consideration as good lighting, quality furniture or fixtures, quality merchandise, competent personnel, or efficient equipment for accounting and record keeping.

In brief, air conditioning in the business world is securing greater sales volume for retail establishments and greater patronage for personal service institutions like beauty parlors, theaters, banks, etc.; it is increasing production and reducing spoilage in factories; it is reducing unnecessary losses previously attributable to goods damaged by handling or to errors of employees who were less efficient because of personal discomfort; it is securing free advertising and greater good will by making patrons comfortable; and it is saving money for employers through increasing productiveness and reducing lost time of salaried employees.

Protection of Building Structure

The value of air conditioning in preserving the structure of the building itself should not be overlooked. The distribution of clean air both in the home and the business building reduces the cost and labor of cleaning, saves money in redecorating costs, and at the same time helps maintain the fresh appearance of interior decoration, furniture, furnishings and merchandise.

The control of humidity with year 'round air conditioning prevents in large measure the drying out of woodwork, floors, furniture, plaster, rugs, drapes and pictures in winter, and the absorption of moisture by these objects on humid days in summer. Without air conditioning, the intermittent drying and moistening causes them to contract and expand, and is, in turn, responsible for large cracks in floors, wood work, breaking of fibers in rugs and drapes, loosening of paint and plaster, and loosening of joints in furniture.

By maintaining reasonably uniform humidity indoors these ravages of time and the seasons are substantially reduced by air conditioning.

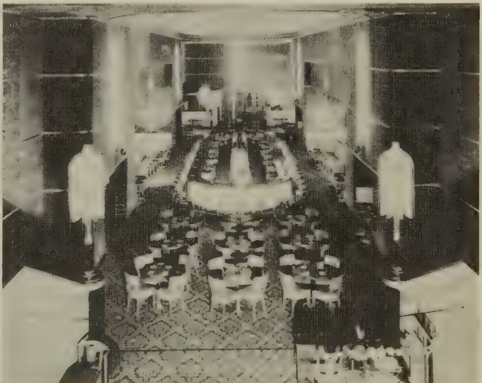


Fig. 15. Cocktail lounge and bar in Mayfair Casino, Cleveland, Ohio, air conditioned with 30 hp G-E system.

HOW MUCH DOES IT COST?

In view of the discussion earlier in this booklet it must be evident that an air conditioning system, carefully designed in all respects to give the purchaser the most for his money, cannot be selected from a catalogue with standard prices for various models, sizes or styles. Instead, the price is determined from careful calculation of all the elements of cost, just as any business man, after analyzing his costs, determines a price which will cover them and allow him a reasonable profit on the transaction.

The history of air conditioning thus far has clearly demonstrated that there are two highly significant facts not always well understood by the purchaser of air conditioning. These two facts are:

1. That the cost of the manufacturer's equipment in all but simple room cooler jobs may be only from 25 per cent to 60 per cent of the total first cost. Hence, if the labor, materials and other expenses of installation work offered by various bidders are the same in amount and quality, a 10 per cent premium for higher quality equipment is reflected as only a 2.5 per cent premium for the total job, if the cost of equipment is 25 per cent of the total.
2. That the initial cost of the completed system is probably the lesser part of the total expenditure by the buyer over a ten-year period. Like an automobile, the operating and maintenance cost may be the major part of the ultimate expenditure.

A booklet entitled "Interesting Facts about Air Conditioning" would be incomplete without a frank discussion of the above two facts and other matters of cost in an effort to give the prospective buyer a clearer understanding of just where his air conditioning dollar will go. Such an analysis should also be helpful in ascertaining the inherent value of proposed air conditioning systems. This discussion is intended to apply only to general pricing practices of responsible concerns where there is due appreciation of the fact that overhead, engineering expense, and other items are legitimate elements of cost, and that there must be a profit on each transaction if the concern is to stay in business and be a reliable source of service to the owner during the years to follow.

A cost analysis of this kind could not, of course, apply to the seller who, because of inexperience or for other reasons, fails to include all legitimate indirect costs, who fails to include all the items necessary for a complete and successful system, or who decides to get a start in the business by selling at or below cost. The occasional seller in this class either soon profits by his mistakes or runs afoul of the laws of economics.

Fig. 16. Auditorium of Rivoli Theater, Long Beach, California, air conditioned with 50 hp G-E system.

The Elements of First Cost

The following are the major elements of cost which must be considered in arriving at the price for an air conditioning system:

1. Equipment, including air conditioner, refrigerating equipment, control devices, coils, fans, motors and other accessories.
2. Installation labor and materials.
3. Freight and delivery.
4. General overhead
5. Engineering expense.
6. Miscellaneous costs such as insurance, permits, licenses, etc.

All of these are legitimate and necessary costs in a successful and progressive organization, and to them must be added a reasonable profit. The price thus obtained is the total cost to the buyer if he has specified a so-called "turn-key job." Frequently, however, the buyer wishes to do part of the installation work himself, such as plumbing, wiring, construction work, painting or redecorating, especially if he is particularly well-equipped to do one or more of these items. Hence, the total first cost is the bidder's price plus the buyer's cost of any work to be done by him.

As previously stated, Item 1, the equipment, may represent less than half the total cost, and in most cases this item of cost will not vary greatly among various responsible bidders, provided, of course, they are all bidding on the same capacity specifications and including the same elements of air conditioning. Equipment costs will probably show substantial variation only if there are wide differences in the general type of system, such as a chilled water system as contrasted to direct expansion of refrigerant, or a multi-zone system as contrasted to a large non-zoned system.

Fig. 17. Interior of First National Bank, Ardmore, Okla., air conditioned with 20 hp G-E system.

The greatest variable in the entire cost structure is the matter of installation cost. The previous list of the possible installation items should indicate the opportunity for variations in extent and quality of this part of the job. In fairness to himself and all the bidders the buyer should insist upon complete details of *every* item of installation work proposed by each bidder.

The element of engineering is worthy of comment. On a small and simple installation the cost of engineering the system is small and therefore has little effect on the price. But on a very large system, such as one for a complete building, the actual cost of doing all the necessary engineering design may run to 8 per cent or 9 per cent of the selling price of the job. This engineering cost is unavoidable and if there are six bidders on such a job each must make this expenditure, and only one can be reimbursed for it. Therefore, on the average, and over a period of time, all bids by various companies must include an amortization of this engineering expense, and on large and complicated installations there can be a saving for all concerned by having the complete engineering done by an air conditioning consulting engineer for a single engineering cost.

To facilitate a fair and accurate study of an air conditioning system, there has been prepared a "Value Analysis Chart" which is obtainable from any authorized G-E Air Conditioning Distributor. This chart makes it possible to quickly analyze and compare every element of a complete system.

Total Owning and Operating Cost

The second of the two important facts just mentioned has to do with the ultimate cost to the owner. The true cost of air conditioning is the average owning and operating cost per year over a specified period of time. This period is not particularly dependent on the life of the equipment, because a good installation will continue to function for more years than are commonly allowed for amortization of an investment of this kind, but is more often dependent on the length of lease or expected period of occupancy of the original premises. For simplicity, and because it is frequently used, let us assume a ten-year period for complete amortization of the investment. The following are the annual costs to own and operate the air conditioning system:

1. Amortization of initial investment—10 per cent per year.
2. Interest on investment at 6 per cent simple interest, or an average of 3⅓ per cent per year on initial investment.
3. Cost of electric power for motors.
4. Cost of water consumed.
5. Maintenance costs, including filter replacements and repairs for ordinary wear. (Repair costs are zero during the first year of free service, but neglecting this fact will have little effect on the total *average* annual cost.)
6. Operating labor costs if system requires an attendant whose salary would otherwise not be paid.

These are the major elements of cost (insurance and tax costs might be mentioned but they ordinarily have no significant effect on the total figure). The owning cost or sum of Items 1 and 2, representing 13⅓ per cent of the total initial investment, will usually be found to be less than half the total annual cost. Thus a 10 per cent higher initial investment actually costs the

Fig. 18. Peacock Beauty Salon, Worcester, Mass., air conditioned with 7½ hp G-E system.

owner less over a ten-year period than a 10 per cent increase in operating cost caused by less efficient machinery.

These points can be more specifically illustrated if we take an actual typical example. Assume that a store owner purchased a 20 hp air conditioning system for summer service, with provision for using the fan and duct system for ventilation, cleaning and circulation in winter. The figures used below are approximate though typical. Actual figures might be either higher or lower, depending on local conditions and the nature and structure of the store. Assume further that the following data apply:

Total first cost: $5,880

Power input to condensing unit motor: 19.6 kw at 2.5¢ per kwh

Power input to fan motor: 2.5 kw at same rate

Condensing unit operates 900 hr per year and fan 2700 hr per year (including winter operation for ventilation).

A demand charge for power of $20 per month for five months during the cooling season.

Water consumption of condensing unit: 1800 gals. per hr at $1 per 1000 cu ft.

Maintenance cost: 1.5 per cent of initial cost per year.

After some arithmetic, we arrive at the following *annual* cost figures:

Amortization and interest	$ 780.00
Yearly power cost (including demand charge)	709.00
Yearly water cost	216.00
Maintenance cost	88.00
Total annual owning and operating cost	$1793.00

Note that the part of the total yearly cost influenced by the first cost is only 43.5 per cent.

Fig. 19. Air conditioned studio of WTMJ, Milwaukee, Wisc. air conditioned by G-E system.

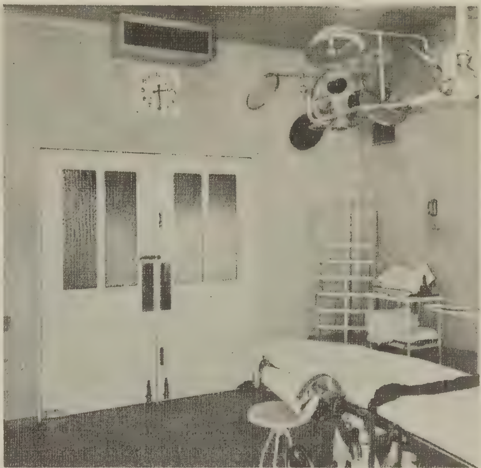


Fig. 20. Air conditioned operating room in St. Luke's Hospital, Chicago, Ill.

Before going further it would be well to check the economy of a cooling tower to conserve water. Assume that a cooling tower could have been purchased for an additional $500, that it would reduce the water consumption 90 per cent, that the power input to a water-pump motor would be 2 kw, and that the other factors remain unchanged.

The above table would now become:

Amortization and interest	$ 847.00
Yearly power cost	754.00
Water cost	22.00
Maintenance cost	96.00
Annual owning and operating cost with cooling tower	$1719.00

Thus in ten years the cooling tower would save about $740.

Let us now analyze the cost of buying a cheaper and less efficient system. Assume one bidder quoted $5380 and that this system used 10 per cent more power for the condensing unit and 20 per cent more cooling water. It is reasonable to assume also that this cheaper system would require more maintenance. Neglecting any change in the demand charge or fan power consumption, our table now becomes:

Amortization and interest	$ 715.00
Yearly power cost	754.00
Yearly water cost	259.00
Maintenance	100.00
Total	$1828.00

Thus the assumed saving of $500 turns out to be a loss of about $35 every year.

Interesting facts about Air Conditioning

The conclusions to be drawn from this analysis are self-evident, and while average figures were used, the results obtained indicate a trend typical of many actual cases. A similar analysis can be made for a heating system based on fuel consumption.

Another Form of True Cost

The annual owning and operating cost of an air conditioning system in dollars is a useful and necessary figure for the business man, but he is also vitally interested in the cost in relation to his gross business. In other words, how much of every dollar of gross annual sales must be set aside to pay this annual cost of air conditioning? Again let us resort to figures.

A gross annual sales volume of $200,000 would not be unreasonable for a progressive store of the size requiring a system like the one used in the previous example. Taking the total annual cost of air conditioning at $1800 in round numbers, the average cost is 9/10¢ per dollar of gross sales. In many actual cases this figure has been found to be more nearly ¾¢ per dollar of gross sales.

To break even on the cost of the air conditioning system, the store must increase its gross profit by $1800 per year during the amortization period. Even if the gross profit margin were only 20 per cent, the required increase in sales volume would be but $9000, or an average annual increase of 4.5 per cent—a figure far less than the typical increases reported by owners of good air conditioning systems.

How much does air conditioning for a retail business cost? The significant conclusions are that an investment in good air conditioning pays a profit, and that the true cost is nearly always substantially less than 1¢ per dollar of gross annual sales.

What about other business institutions—the office building, the theater, the beauty parlor, etc.? A similar cost analysis can be made for other business air conditioning installations to show how the true owning and operating cost of air conditioning is related to the other cost of doing business. A G-E trained engineer will be glad to help you make this cost analysis for your particular business.

Airplane view Bloomfield Works, Air Conditioning Department, General Electric Company

General Electric Air Conditioning Products

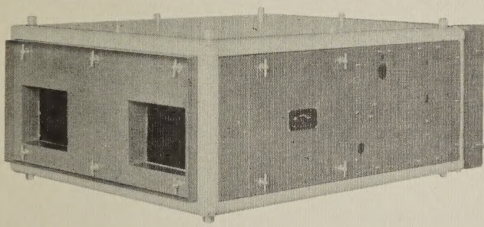
General Electric Air Conditioning Products Are Compact

The pictures on this and the following two pages illustrate the unusually broad line of General Electric Products for air conditioning. It is by means of this product line that General Electric is able to offer systems truly co-ordinated in design—each product being complete with all essential parts designed to work together, with co-ordinating controls designed to help them work together. It is with these many high quality products that G-E Air Conditioning Distributors create well-engineered systems, offering minimum operating cost and long life, backed by a single, unified responsibility.

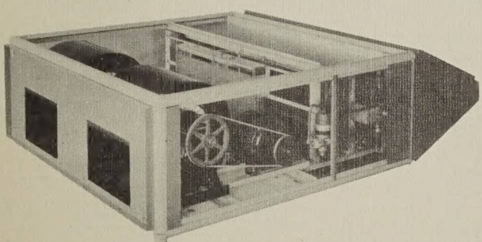
Detailed specification data on any of these products may be obtained from the G-E Air Conditioning Distributor.

HORIZONTAL CENTRAL PLANT AIR CONDITIONERS

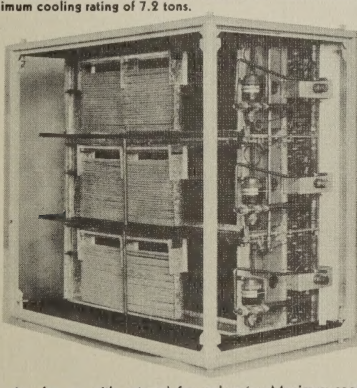
G-E Type HD Air Conditioners are unique in the industry, in being the most complete line of factory-built and tested central plant units. They are good-looking, quiet in operation, accurately rated, readily accessible, and easy to install. To appreciate their quality and performance, one must see them in operation. They are available in eight basic sizes and hundreds of combinations, for summer, winter, or year 'round service. Maximum ratings given below are based on the following standard conditions: entering air, 80 D.B. and 67 W.B.; refrigerant temperature, 40 degrees.



HD-100 series. Maximum cooling rating about 4.2 tons. Has built-in direct-driven G-E Radial Flow Aphonic Fan.



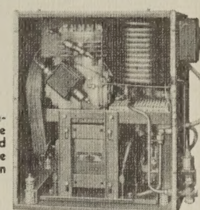
HD-300 series, shown without top and side panels. Maximum cooling rating about 14.4 tons. Belt-driven G-E fan. A similar, but smaller series, HD-200, has a maximum cooling rating of 7.2 tons.



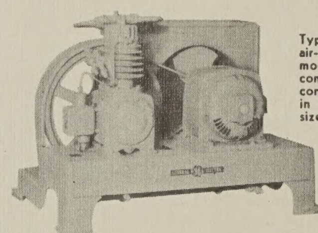
HD-600 series, for use with external fan and motor. Maximum cooling rating about 41.7 tons. There are also HD-400, HD-500, and HD-700 series similar to HD-600 but with different dimensions, and having maximum cooling ratings of about 21.6, 27.8 and 55.5 tons, respectively.

CONDENSING UNITS

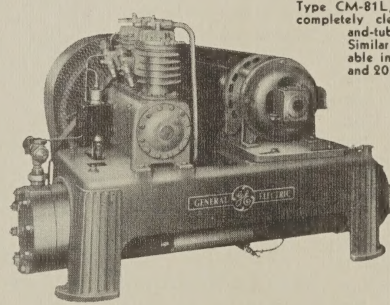
G-E Air Conditioning Condensing Units are available in 28 basic models in sizes from 1 to 50 horsepower. They are the result of over twenty-five years of experience in designing and building millions of refrigerating machines. These machines offer the buyer the lowest operating and maintenance cost plus smooth and reliable operation.



Type CM-57, 1 hp., water cooled condensing unit with sound-proof enclosure and motor cooling coil as standard equipment. A similar 1 hp. model, Type CM-5W, is available without an enclosure.

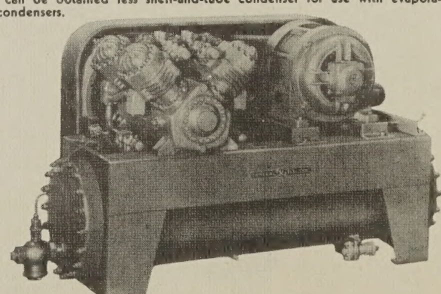


Type CM-62A, 1 ½ or 2 hp., air-cooled. Water cooled models, with shell-and-coil condensers or counter-flow condensers are also available in 2, 3, 5, 7 ½ and 10 hp. sizes



Type CM-81L, 5 hp., with completely cleanable shell-and-tube condenser. Similar models available in 7 ½, 10, 15 and 20 hp. sizes.

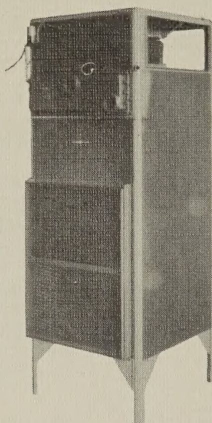
Type CM-123K, 40 hp. Also available in 30 and 50 hp. sizes. All three sizes can be obtained less shell-and-tube condenser for use with evaporative condensers.



For All Air Conditioning Applications

General Electric Air Conditioning Systems Are Safe and Reliable

VERTICAL CENTRAL PLANT AIR CONDITIONERS



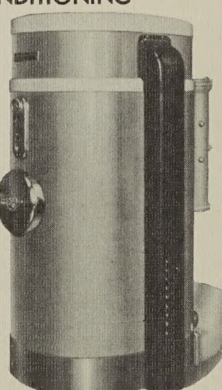
The Type AA Central Plant Air Conditioners are especially designed for residential winter air conditioning; they are quiet and work in conjunction with the G-E Oil or Gas Furnaces by means of an automatic, co-ordinated control system.

Type AA-3 (at left) has a heating rating of 130,000 Btu/hr. Type AA-4 (not shown) has rating of 260,000 Btu/hr.

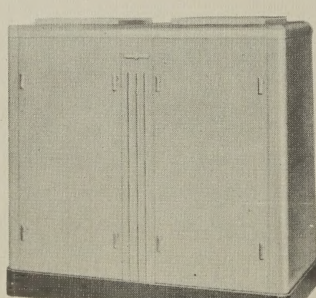
OIL-FIRED EQUIPMENT FOR HEATING AND WINTER AIR CONDITIONING

The Furnace and Direct-Fired Air Conditioner pictured here use the famous G-E "Inverted Flame" method of burning oil to provide lowest fuel costs, quiet operation and absolute safety for the home owner. These unusual furnaces are also being widely used to furnish heat and hot water for business buildings.

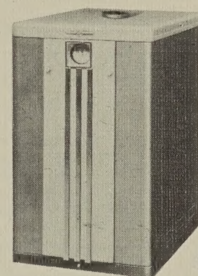
At right, Type LA-5 Oil Furnace with heating rating of 275,000 Btu/hr., for steam or hot water. Models rated at 133,000 Btu/hr. also available.



Type LB-3 (below) direct-fired winter air conditioner. Heating rating 100,000 Btu/hr. Also larger models.

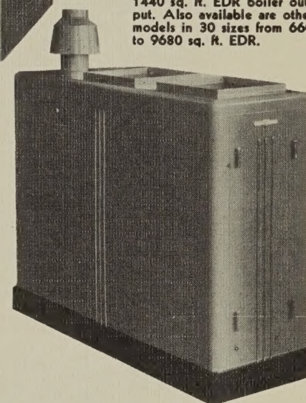


GAS-FIRED EQUIPMENT FOR HEATING AND WINTER AIR CONDITIONING



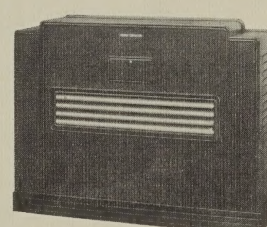
Where gas is the accepted fuel the G-E Gas Furnaces and Direct-Fired Air Conditioners, like the oil-fired equipment, are co-ordinated in design to give maximum economy, dependability and safety.

Type LM Gas Furnace available in 8 sizes from 320 to 1440 sq. ft. EDR boiler output. Also available are other models in 30 sizes from 660 to 9680 sq. ft. EDR.

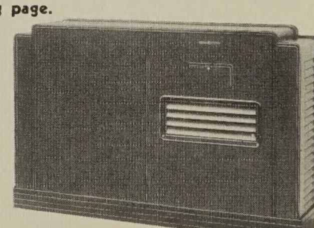


Type LG-2 direct-fired winter air conditioner, 70,500 Btu/hr.
Also available are Type LG-1, 35,250 Btu/hr; Type LG-3, 105,750 Btu/hr., Type LG-4, 141,000 Btu/hr.

YEAR 'ROUND ROOM AIR CONDITIONERS



Type AD-4 (above) is a complete year 'round room unit with window duct connection for ventilation. Designed for use with remotely located air- or water-cooled condensing unit of 1 or 1½ hp. Also available is half-size unit, Type AD-3. Type FR-1 (below) performs same functions but has built-in condensing unit, Type CM-57, shown on preceding page.

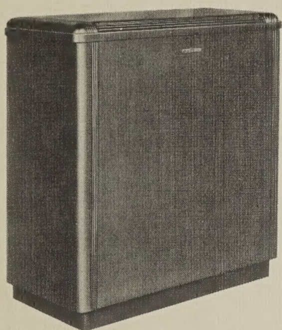


For an Entire Building or a Single Room

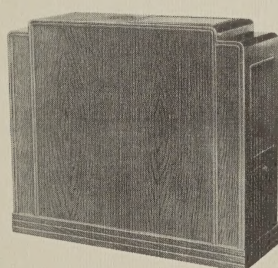
A General Electric Air Conditioning System Is a Co-ordinated System

SUMMER AIR CONDITIONERS AND ROOM COOLERS

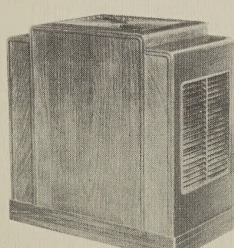
Self-contained summer air conditioning units are designed to cool a room of small or medium size at lowest installation cost. Room Coolers for floor mounting or ceiling suspension are designed for use with a remote condensing unit. They offer a simple solution to the problem of cooling a room or small store where the use of a duct system is undesirable.



Type AF-1 summer air conditioner with self-contained air-cooled conditioning unit. Requires only power connection. No water or drain connection normally necessary. Cooling rating about ⅔ ton and can be increased to 1 ton by supplying very small water line plus minor changes in mechanism. Semiportable.

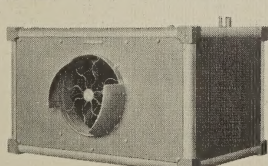


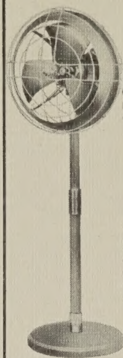
Type FC-1, with self-contained water-cooled condensing unit. Has ½ hp. motor and can be plugged into most lighting circuits. For small rooms where outdoor window connection is not available. Rating about 4500 Btu/hr. Semiportable.



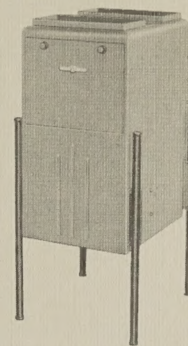
At right, Type AG-2 floor-mounted room cooler for remote condensing unit. Capacity about 1 ton. Extremely quiet in operation. Also available in smaller capacity, Type AG-1, and in wall-mounted model, Type AG-10.

Below, Type AG-12 suspended room cooler equipped with filters. Capacity about 2 tons. Also available are Types AG-14 and AG-15, of about 2½ and 3½ tons respectively.



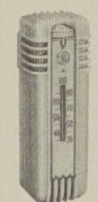


AIR CIRCULATORS—Type HV-1D pedestal-mounted (left). Also available arranged for shelf mounting or exhaust fan mounting.

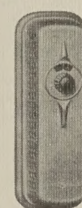


AIR CONDITIONER FOR WINTER—Type HW-1 (right) humidifies, tempers, circulates and cleans the air. Used in conjunction with heating boiler and requires simple duct system.

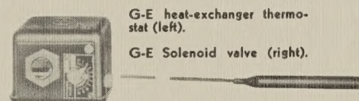
MOTORS AND CONTROLS



Electric air conditioning depends for its existence on motors which drive the compressors, fans and auxiliaries, and on the controls which regulate and protect the equipment. General Electric makes its own motors and controls, and this is one of the reasons for General Electric co-ordinated products and systems.

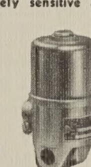


General Electric Thermostats and Humidistats are extremely sensitive and reliable.

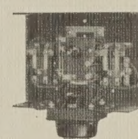


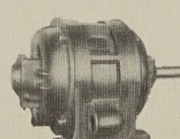
G-E heat-exchanger thermostat (left).

G-E Solenoid valve (right).



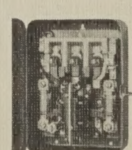
G-E Thermostat control panels make possible the use of low-voltage thermostats and humidistats.





G-E Motors drive G-E Air Conditioning apparatus efficiently, quietly and reliably.

There is the correct G-E Motor Starter for every G-E Motor.



RECIPE
FOR GOOD
AIR CONDITIONING

It was tacitly assumed that the discussions in the foregoing pages related only to high quality air conditioning, and it is fitting to conclude with a summary of the attributes of a good air conditioning system.

The value of an air conditioning installation lies not in the possession of a certain amount of equipment, but in the ability of the system to produce specified results under the design conditions, to provide continued satisfaction, to present an attractive appearance, to give continued and reliable service quietly and at minimum cost of operation and maintenance and throughout a long period of useful life.

These benefits can result only from the use of equipment that is high in quality, modern in performance, adequate in capacity, and properly selected for the job by experienced, well-trained and conscientious engineers.

Such equipment and application engineering must in turn come from a company with unlimited research facilities for the development of apparatus, with facilities for precision manufacture of products, and with a broad and continuous training program for its distributors' engineers, based upon the realization that more than half of the success of an air conditioning installation is dependent upon the way in which it is designed to meet the owner's requirements.

A recipe for good air conditioning is—

GENERAL ELECTRIC
AIR CONDITIONING

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